

## Claims

What is claimed is:

1. A state estimation system for determining possible values of a measured data item comprising:
  - a computer;
  - at least one measurement input to the computer measuring the data item, said measurement corrupted by noise;
  - a computer output device;
  - at least one restriction on the measured data item, said restriction available in memory to the computer; and
  - a software module operating on the computer for calculating at least one estimate of the state of the measured data item based upon the measurement input and the restriction, and sending the estimate to the output device;wherein the software module calculates the estimate by:
  - representing the state space of the measured data item as a finite set of points using the restriction; and
  - applying a decision rule, said decision rule based on the finite set of points, to the measurement input.
2. The system of claim 1 wherein the decision rule is minimax, Bayes or Gamma-minimax.
3. The system of claim 1 wherein prior statistical information about the measured data item is available in memory to the computer, and the decision rule uses the statistical information.

4. The system of claim 1 wherein the measured data item is comprised of a plurality of values.
5. The system of claim 1 wherein the decision rule is based upon a loss function.
6. The system of claim 5 wherein the loss function is zero-one or squared-error.
7. The system of claim 1 wherein the estimate forms a confidence set.
8. The system of claim 1 wherein the output device is a second software module.
9. A system for making decisions related to a task comprising:
  - a computer;
  - at least one confidence set available to the computer in memory, said confidence set describing the value of a first state variable;
  - a task definition available to the computer in memory;
  - a description of possible decisions available to the computer in memory;
  - a description of effects of the possible decisions on a second state variable available to the computer in memory;
  - a computer output device;
  - a software module operating on the computer for making decisions based on the confidence set, the task definition, the possible decisions and the description of effects, and sending the decision to the output device;
  - wherein the software module selects at least one decision from the possible decisions by:
    - performing calculations on the effects of possible decisions on the second state variable, while restricting the calculations based upon the confidence set; and

evaluating values resulting from the calculations for compatibility with  
the task definition.

10. The system of claim 9 wherein the confidence set is provided by a state estimation system.
11. The system of claim 9 wherein the first state variable and the second state variable are each a vector comprised of at least one variable.
12. The system of claim 11 wherein some or all of the variables in the first vector are the same as some or all of the variables in the second vector.
13. The system of claim 9 wherein there is a plurality of confidence sets from different sources and the information contained in said confidence sets is fused.
14. The system of claim 9 wherein the output device is a second software module.
15. A state estimation method for determining possible values of a measured data item using a computer to perform the following steps:
  - reading at least one measurement corrupted by noise;
  - determining at least one restriction on the measured data item;
  - calculating at least one estimate of the state of the measured data item based upon the measurement and the restriction by:
    - representing the state space of the measured data item as a finite set of points using the restriction; and
    - applying a decision rule, said decision rule based on the finite set of points, to the measurement input; and
  - sending the estimate to an output device.

16. The method of claim 15 wherein the decision rule is minimax, Bayes or Gamma-minimax.
17. The method of claim 15 wherein prior statistical information about the measured data item is available in memory to the computer, and the decision rule uses the statistical information.
18. The method of claim 15 wherein the measured data item is comprised of a plurality of values.
19. The method of claim 15 wherein the decision rule is based upon a loss function.
20. The method of claim 19 wherein the loss function is zero-one or squared-error.
21. The method of claim 15 wherein the estimate forms a confidence set.
22. The method of claim 15 wherein the output device is a software module.
23. A method for making decisions related to a task using a computer to perform the following steps:
  - reading at least one confidence set, said confidence set describing the value of a first state variable;
  - reading a task definition;
  - reading a description of possible decisions;
  - reading a description of effects of the possible decisions on a second state variable;
  - selecting at least one decision based on the confidence set, the task definition, the possible decisions and the description of effects by:

- performing calculations on the effect of possible decisions on the  
second state variable, while restricting the calculations based  
upon the confidence set; and  
evaluating values resulting from the calculations for compatibility with  
the task definition; and  
sending the selected decision to an output device.
24. The method of claim 23 wherein the confidence set is determined by a state estimation method.
25. The method of claim 23 wherein the first state variable and the second state variable are each a vector comprised of at least one variable.
26. The method of claim 25 wherein some or all of the variables in the first vector are the same as some or all of the variables in the second vector.
27. The method of claim 23 wherein there is a plurality of confidence sets from different sources and the information contained in said confidence sets is fused.
28. The method of claim 23 wherein the output device is a software module.

## **Abstract**

An automated system and a method for estimating quantities from their measured values, incorporating these estimates into decision making processes, and combining these estimates with other available knowledge (e.g. statistical, physical and logical models) are provided.

5 Estimation is performed by utilizing finite compact representations to capture the structure of continuous or large discrete problems, allowing efficient computation of decision rules. The representations are exact, so the resulting solutions are not approximations. Decision making is accomplished by selecting decisions based on the task to be completed, results of the